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Enhancing Efficiency of Single, Large-Aperture Antennas

A numerical analysis approach may provide a means of describing the energy distribution in the focal plane of a parabolic surface in terms of phase and wavelength. The study program should be useful in designing and constructing parabolic antennas with improved adaptive feed characteristics and efficiency, and should interest designers and manufacturers of high frequency radio antennas, and research personnel investigating electromagnetic propagation and reception phenomena.

The primary emphasis of this program was to examine the parameters and techniques for enhancing the efficiency of single, large-aperture antennas, such as those used in extremely long range communications systems. Two basic approaches were investigated for the microwave region up through the millimeter wavelengths: a single, large reflector focused to a feeding element; and an array of smaller apertures whose individual outputs are summed.

Calculations were performed to determine the relative distribution of energy that could be recovered by a multiple-element feed system. These calculations were based on computer analyses of the field structure in the focal plane of the aperture focused in the near field. The results were plotted, and the area under the curve was planimetered. After seven sidelobes, the power (area under the curve) had diminished to such an extent that the addition of more sidelobes probably would not change the total substantially. Assuming the area under the main beam and the first seven sidelobes to be the total area, the main beam subtends 50.72% of the total, indicating the maximum efficiency achievable with a single element feed. However, if a multi-element feed were designed to capture the first two sidelobes along with the main beam, the maximum efficiency would be increased to 79.88%. This increase is considerable and warrants continued effort toward the design of such a feed.

The immediate benefit from developing an adaptive feed based on the results of this research is higher antenna efficiency. The lower sidelobe levels would be effected by adaptively feeding ground-based parabolic antennas, making secure communication systems easier to devise. Also, lowering the effective antenna temperature on large radiometric antennas represents an important achievement. A large part of the noise temperature is due to the sidelobes digging into the hot earth; these sidelobes could be reduced drastically by a focal plane adaptive feed system. Efforts should be extended toward developing a practical adaptive feed system. Further analysis will be performed to determine the effects in the focal plane for off-axis angles of arrival. The solutions for these angles can then be weighted properly and added to synthesize surface errors in the parabolic reflector.

Note:

The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0.95)

Reference:
NASA-CR-101352 (N69-27894), Interplanetary Communications Study Final Report

(continued overleaf)

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No patent action is contemplated by NASA.

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